Water and saline stress: Effects on shoot and root growth in *Arabidopsis thaliana*

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Growth Conditions

- 16 hours of light
- Ambient temperature (Average 24-25°C)
- Standard soil mixture No fertilizer

Treatments and Strains

The 4 treatments:

	Flood	Drought
Water	1) Control	2) Drought
Saline	3) Salt	4) Drought and Salt*

* Plants in the Drought and Salt treatment are exposed to less salt than those in the Salt treatment, but also less water. Does this enhance or diminish the effect of the salt?

Flood= 1" of water, continuous
Drought = 1" of water for a few hours every 2-4 days
Saline solution = 3.34g/ L in tap water (3.34 ppt, approximately 10% of seawater)

The 3 strains:

Strain	Response to saline and/or water stress
Columbia (wild type)	Uses the hormone abscissic acid (ABA) to close stomates and retain water. Prolonged water stress degrades membrane lipids. Salt stress leads to dehydration.
ABA 2-3 (ABA resistant)	Described as 'salt resistant'. Stomates remain open under salt and water stress leading to increases rate of water loss, wilting, reduced growth and vigor.
SOS 4-1 (Salt overly sensitive)	In response to NaCl stress, *SOS4* mutant plants accumulate more Na and less K , show defective root hair initiation and slower root and shoot growth, than do wild-type plants. The lower K content and higher Na content in the roots of *SOS4* mutant plants indicate a role of *SOS4* in regulating K and Na transport.

Abstract

Three *Arabidopsis* thaliana plant strains: *ABA 2-3*, *SOS 4-1*, and wild type Columbia-0 (Col-0), were exposed to varying combinations of salt and drought stress. In the salt treatments, plants were watered with a solution of 3.34 grams/L of de-iodized table salt in tap water. In the drought treatments, the plants were thoroughly soaked for a few hours then drained for 2-4 days. The control plants were continually flooded in 1" of standing water. Stem length, leaf number, and rosette diameter were measured every three days and root length was determined at the end of the experiment. Initially, twenty-seven plants germinated: two of the *ABA 2-3*, eleven Col-0, and twelve *SOS 4-1*. The only strain to survive throughout the experiment was the wild type Col-0. The *ABA 2-3* strain demonstrated drought resistance, as hypothesized. Surprisingly, the *SOS 4-1* strain was affected more severely by drought than salt. Drought and salt together had a more severe effect on the wild type plants than either treatment alone, but this was not true for the *SOS 4-1* plants.

Hypothesis

- *Arabidopsis thaliana* salt sensitive, ABA salt resistant, and wild type strains, will resort to dehydration, lowered photosynthetic processes, and stunted growth in drought and high salinity concentrations. Out of the three, salt sensitive will struggle the most and wild type will resist the most. However, plants with aba salt resistant mutants may overcome dehydration due to excess water and its resistance to salt.

"Virtually every aspect of plants physiology as well cellular metabolism is affected by salt and drought stress."

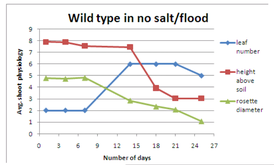
Mahajan, Shilpi and Narendra Tujeta. "Cold, salinity and drought stresses: An overview." Archives of Biochemistry and Biophysics (2005): 139-158.

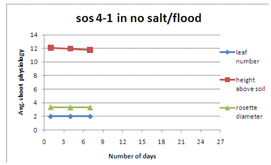
Future Research

•Repeat these studies with larger numbers of plants to ensure robustness of our results.
• Examine root development in more detail, especially root mass and morphology, such as branching.
• Create additional treatments designed to determine how pH and availability of mineral nutrients interact with stress regulating mechanisms.

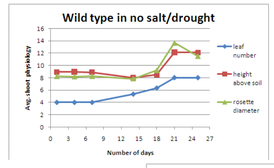
Results

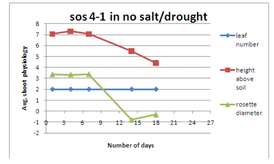
Control



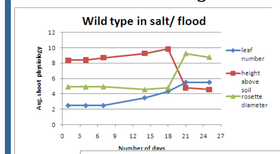


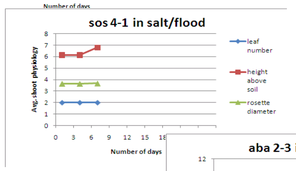
Drought
Root length = 20.3 mm (n=1)



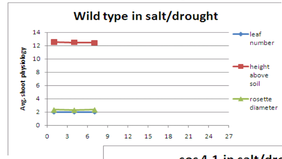


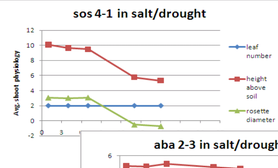
Salt
Mean root length = 9.1 mm (n=3)

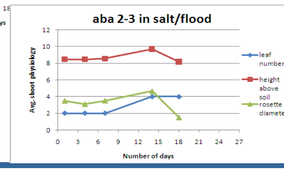


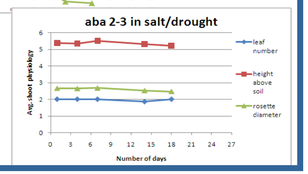


Drought and Salt









Conclusions

1. All plants showed signs of dehydration and inhibited growth in salt and drought.
   - High mortality, lack of increase in leaf number, decline in rosette diameter and height above soil.
2. Columbia performed well in all treatments except Drought and Salt.
3. *ABA 2-3* and Columbia were more resistant to saline stress than *SOS 4-1*.
   - Managed to stay alive much longer than *SOS 4-1* in Salt and Drought and Salt.
4. Control was at least as unfavorable for *SOS 4-1* survival as Salt.
   - High mortality in both

Some aba2-3, sos4-1, and wild type plants responded as hypothesized

- Four wild type plants survived all three treatments except Drought and Salt (extreme conditions).
- Responded with more resistant, than other strains, to mild salt and drought treatments.
- *ABA 2-3*and *SOS 4-1* did not survive saline and drought stress.
- *ABA 2-3* showed more resistance to salt than *SOS 4-1*.

Contradictions to hypothesis

- *ABA 2-3* did not germinate in Control and Drought and did not overcome dehydration from excess water.